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Strategies for Supporting Diversity in K-12 STEM Education: A Systematic Literature Review

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Abstract

Participation in STEM education and careers in Australia remains persistently unequal across gender, cultural background, disability, geographic location, and socioeconomic status. While a substantial body of research has examined strategies for supporting girls in STEM, less is known about how these strategies generalise across the full range of diversity groups now recognised in the Australian STEM equity monitor. This systematic review, conducted in accordance with PRISMA guidelines, examined school-based strategies for promoting, supporting, and retaining diverse K–12 students in STEM. Four databases (ERIC, Education Source, A+ Education, and ACM Digital Library) were searched for peer-reviewed English-language studies published between 2020 and 2025, yielding 5,400 records. Following screening and quality assessment, 134 studies met inclusion criteria and were retained for thematic analysis. Girls (47%), culturally and linguistically diverse students (22%), and students with disabilities (17%) dominated the dataset, while LGBTQIA+ students and First Nations Australians were each represented in fewer than 2% of studies. Thematic analysis of 59 codes produced eight overarching themes, with creating safe and inclusive learning environments, hands-on and experiential learning, culturally responsive pedagogy, and connections to careers and role models emerging as the most consistently evidenced strategies. Findings indicate that while individual and programmatic interventions can meaningfully improve engagement and belonging, they are insufficient alone to address the systemic inequities shaping STEM participation. Sustained change requires coordinated action across classroom practice, curriculum design, teacher education, and policy. The marked scarcity of evidence for LGBTQIA+ students and First Nations Australians highlights an urgent need for targeted research to ensure equitable STEM outcomes for all students.

Introduction

Science, technology, engineering, and mathematics (STEM) education provides students with the critical thinking, problem-solving, and technical skills required to participate in and shape a rapidly evolving global economy (Dare et al., 2021). From early childhood through secondary schooling, STEM learning forms a foundational pillar of modern education, equipping young people with the knowledge and competencies needed to engage with complex societal challenges, including climate change, public health, and digital transformation (Freeman et al., 2015; Office of the Chief Scientist, 2020). Despite its importance, participation in STEM education and careers remains unequal, with longstanding disparities evident across gender, cultural background, disability status, geographic location, and socioeconomic circumstance (Department of Education, 2021).

Creating an inclusive and diverse STEM workforce is critical for driving innovation and sustainable economic growth. However, the Australian STEM Equity Monitor Data Report (Department of Industry Science and Resources, 2025) reveals that only 29% of women make up STEM-qualified industry employees. Similar numbers are reflected in culturally and linguistically diverse (CALD) employees, who contribute 28% of the total STEM workforce. Concerningly, only 2% of STEM employees are First Nations Australians and 1% are people with a disability (Department of Industry Science and Resources, 2025). These figures highlight a persistent and systemic inequity that is apparent in the workforce but starts in the classroom.

Systemic barriers continue to limit access and participation in STEM education for many students from diverse backgrounds. Students with disabilities, gender-diverse students, girls, those from remote and regional areas, First Nations Australians, CALD students, and students from low socioeconomic backgrounds face intersecting challenges including stereotypes, biases, limited access to role models, restricted understanding of STEM career pathways,

disengagement from STEM learning, and varied family and community influences (Boda, 2024; Rainey et al., 2018; Yang et al., 2024). Research demonstrates that stereotyped perceptions of STEM careers and professionals can develop from early childhood and become entrenched across primary and secondary schooling (DeWitt et al., 2014; Master et al., 2025). Without early and sustained intervention, students from underrepresented groups may disengage from STEM subjects well before critical transition points, making ongoing strategies essential across all year levels (Godwin et al., 2013; Rainey et al., 2018).

Many barriers to STEM participation are influenced by controllable factors within educational settings. Growth mindsets, culturally responsive pedagogy, accessible learning environments, and authentic connections between STEM and students lived experiences can significantly impact motivation, self-efficacy, and perceptions of belonging (Spruill et al., 2021; Tofel-Grehl et al., 2024; Yamaguchi et al., 2023). Students from diverse backgrounds often prioritise careers that align with personal identity, community values, and social impact, as well as the opportunity to address issues affecting their communities (Rainey et al., 2018; Tripp & Waight, 2024). The role of education in shaping this sense of identity and purpose is therefore critical.

Schools and classrooms play a pivotal role in creating equitable STEM learning environments that recognise and respond to diverse student identities and needs. Teachers and peers serve as critical sources of STEM engagement, encouragement, and role modelling, with 30% of friends and 24% of teachers cited by young people as the most influential figures in their STEM subject selection (Department of Industry, 2020; Master et al., 2025; Rainey et al., 2018). Classroom culture, inclusive pedagogy, and deliberate attention to both intrinsic and extrinsic value in STEM learning have been shown to increase engagement and achievement across diverse student populations (Steegh et al., 2021; Tofel-Grehl et al., 2024; Veldman et al., 2021). Equity-focused teaching and learning environments can inspire all students, regardless of

gender, ability, cultural background, geographic location, or socioeconomic status, to engage more deeply with STEM and provide the conditions where students can envision themselves as future STEM contributors and leaders (Bindis, 2020).

Background

What is STEM Education and Why is it Important?

STEM is an integrated educational framework that encompasses the disciplines of science, technology, engineering, and mathematics. Rather than treating these fields in isolation, contemporary approaches to STEM education often emphasise interdisciplinary connections, inquiry-based learning, and the application of knowledge to real-world contexts (English, 2016; Kennedy & Odell, 2014). In the early years of schooling, STEM education cultivates foundational competencies such as curiosity, logical reasoning, and collaborative problem-solving, capacities that are increasingly recognised as essential for participation in the 21st-century global economy (Clements & Sarama, 2016; Office of the Chief Scientist, 2020).

The importance of STEM education extends beyond individual career outcomes to building the capacity of workforces to solve complex contemporary problems across disciplines, regardless of career choice. As economic and societal challenges increasingly demand collaboration across fields, a skilled STEM workforce is central to national productivity, technological advancement, and the capacity to respond to complex global challenges (Kavak, 2023). The Australian Government has identified STEM capability as a national priority, recognising that investments in STEM education from the early years through to senior secondary schooling are essential for long-term economic competitiveness (Department of Education Skills and Employment, 2015; Office of the Chief Scientist, 2020). Critically, early engagement with STEM learning is associated with stronger academic trajectories, higher rates of subject selection in secondary schooling, and greater representation in STEM tertiary pathways (DeWitt et al., 2014; Maltese & Tai, 2010). This makes the K-12 period a particularly important window for building interest, confidence, and identity in STEM.

What is Diversity in STEM?

Diversity in STEM refers to the equitable representation and meaningful inclusion of individuals from a broad range of social, cultural, and demographic backgrounds in STEM education and careers (Department of Industry Science and Resources, 2025). Recognising that homogeneous STEM environments limit the range of perspectives, ideas, and innovations that can emerge, researchers and policymakers have increasingly called for diversity to be treated as both a moral imperative and a strategic priority (Freedman et al., 2023; Xu et al., 2025).

In Australia, the diversity groups most impacted by inequity within STEM have been identified through the Diversity in STEM Review and are now monitored through the Australian STEM Equity Monitor (Department of Industry Science and Resources, 2025). The STEM equity monitor has recently been expanded beyond its original focus on girls in STEM to now encompass several key diversity groups: women and girls; Lesbian, gay, bisexual, transgender, queer, intersex, asexual and other gender diverse (LGBTQIA+) people; First Nations people (Aboriginal Australian and Torres Strait Islander people); culturally and linguistically diverse (CALD) people; people with a disability, including neurodivergent individuals; people from regional and remote locations; and people from low socioeconomic areas (Department of Industry Science and Resources, 2025). This expanded framework reflects growing recognition that diversity is multi-dimensional and that intersecting identities, such as being a First Nations woman from a regional area, can compound disadvantage and require targeted responses (Whitcomb et al., 2021).

Why does Society need Diversity in STEM?

The rationale for increasing diversity in STEM is both ethical and pragmatic. From an equity perspective, all students deserve access to high-quality STEM education and the opportunities that STEM careers provide, regardless of gender, cultural background, disability, geographic location, or socioeconomic circumstance. This is not only an ethical societal

obligation but also aligns with the fourth United Nations Sustainable Development Goal (SDG) which aims to ensure inclusive and equitable quality education opportunities are provided for all (Department of Economic and Social Affairs, 2025). Persistent underrepresentation of specific groups in STEM reflects systemic inequities that demand immediate attention (Agrawal et al., 2016; Xu et al., 2025).

From an economic and innovation perspective, diverse teams consistently outperform homogeneous ones in problem-solving, creativity, and decision-making (Freeman et al., 2015; Jones et al., 2020). Australia faces a growing demand for skilled STEM workers, and meeting this demand requires drawing from the full breadth of its population. The Diversity in STEM Review noted that increasing diversity in STEM has numerous societal and individual benefits, and that embracing underrepresented groups is essential for Australia to meet future workforce needs (Department of Industry Science and Resources, 2025). Diverse STEM professionals are more likely to develop solutions that reflect the needs and experiences of broader communities, thereby enhancing the social relevance and impact of STEM innovation (Jones et al., 2020).

What is the Current State of Diversity in STEM in Australia?

Despite sustained policy attention, Australia's STEM workforce remains significantly underrepresented in the broader population (Department of Industry Science and Resources, 2025). These disparities are mirrored in educational participation data, where significant gaps in STEM subject selection and achievement persist across diverse groups from primary through to senior secondary schooling (Department of Education, 2021).

To address these inequities, a range of national, state, and sector-level initiatives have been introduced. Programs such as ‘Get into STEM: Diversity in STEM Toolkit’ (previously Girls in STEM Toolkit), STEM Professionals in Schools, and Deadly Science have sought to increase

engagement among underrepresented groups by providing mentoring, role modelling, and culturally responsive learning experiences (CSIRO, 2026; Deadly Science, 2026; Education Services Australia, 2026). The Australian Curriculum's cross-curriculum priorities, including Aboriginal and Torres Strait Islander Histories and Cultures, provide a framework for embedding culturally relevant content within STEM learning (Australian Curriculum Assessment and Reporting Authority (ACARA), 2026). Additionally, the National STEM School Education Strategy 2016-2026 and associated policy frameworks have encouraged schools to adopt evidence-informed approaches to inclusive STEM teaching (Department of Education Skills and Employment, 2015).

Despite these resources and policies, the effectiveness of these initiatives varies considerably across school types, geographic regions, and diversity groups. Many programs remain disconnected, short-term, or insufficiently evaluated, limiting their scalability and sustained impact (Office of the Chief Scientist, 2020; Parsons & Banks, 2024). Sustained success in STEM education requires sustained engagement; however, creating and maintaining engagement is more challenging for teachers and students who experience intersecting types of disadvantage. Sustained engagement may be more challenging for those in regional, rural and remote communities where geographic barriers compound with additional barriers such as social and economic disadvantage. Research suggests that sustained success in STEM education programs depends on several interconnected factors, such as the depth of institutional integration and diverse funding sources (Parsons & Banks, 2024). While policy sets the strategic direction and outreach initiatives provide students with experiences that can spark interest in STEM, the classroom is a key place where a student's STEM identity is formed, and study pathways are forged. There is a clear need for research to inform high-level policy and advice for increasing diversity in STEM and generating evidence-based findings that can inform and guide inclusive teaching practices in classrooms. A greater understanding of which school-

based strategies are effective, for whom, and under what conditions is needed to guide future investment, policy and practice.

Purpose of the Review

This systematic literature review aims to synthesise current evidence on school-based strategies for supporting diversity in K-12 STEM education. By examining the strategies being implemented, their effectiveness, and the factors that enable or impede their success, this review seeks to provide educators, policymakers, and researchers with a rigorous evidence base to inform future practice and policy. The review is guided by the following research questions:

RQ1: What school-based strategies are currently being used to promote diversity in K-12 STEM education?

RQ2: How effective are current school-based diversity strategies in improving the participation and retention of underrepresented groups in STEM?

RQ3: What individual, institutional, and systemic factors enable or hinder the success of diversity initiatives in school-based STEM education?

Together, these questions reflect a commitment to understanding not only what is being done to support diversity in STEM, but how and why certain approaches succeed or fail, and what broader conditions must be addressed to achieve.

Methodology

This systematic review followed PRISMA guidelines and explored strategies used to promote, support, and retain diverse students in STEM education (Page et al., 2021).

Search Strategy

The following pre-defined eligibility criteria were used to identify relevant research:

a. Studies focus on one of the diversity groups identified.
b. Subject domains were within STEM education
c. Participants were students in Kindergarten to Year 12
d. Studies were published between 2020 and 2025 in English
e. Studies were peer-reviewed articles

Studies were also required to address at least one of the reviewers' research questions.

A literature search was conducted by the first author in October 2025. Databases searched were electronic within the areas of education and social science. Four databases were searched: ERIC via EBSCOhost, Education Source via EBSCOhost (previously Education Research Complete), A+ Education via inform-it and ACM Digital Library.

Search terms "STEM" OR "Science, technology, engineering and mathematics" were coupled with "girls" OR "female" OR "gender diverse" OR "LGBTQIA*" OR "non-binary" OR "First Nations Australian" OR "Indigenous Australian" OR "Aboriginal People" OR "Torres Strait Islander People" OR "culturally and linguistically diverse" OR "CALD" OR "EALD" OR "ESL" OR "disability" OR "neurodivergent" OR "regional" OR "remote" OR "rural" OR "low socioeconomic" OR "economic disadvantage" OR "inclusive". A full summary of all search details can be found in Appendix 1 of the supplementary material.

The search strategy yielded 5400 initial sources (Fig 1). After removing 4353 duplicates, 1047 full-text peer-reviewed articles remained for preliminary screening. Title and abstract review led to the exclusion of 831 records that failed to meet selection criteria, leaving 261 publications for retrieval. A further seven records could not be retrieved, resulting in 209 studies for comprehensive assessment, of which 67 were excluded for not aligning with selection parameters. Final full-text analysis identified 142 full-text peer-reviewed articles that met all eligibility requirements. During this final screening phase, two additional authors independently evaluated the articles against the inclusion criteria to confirm eligibility and validate the statistics included in the analyses.

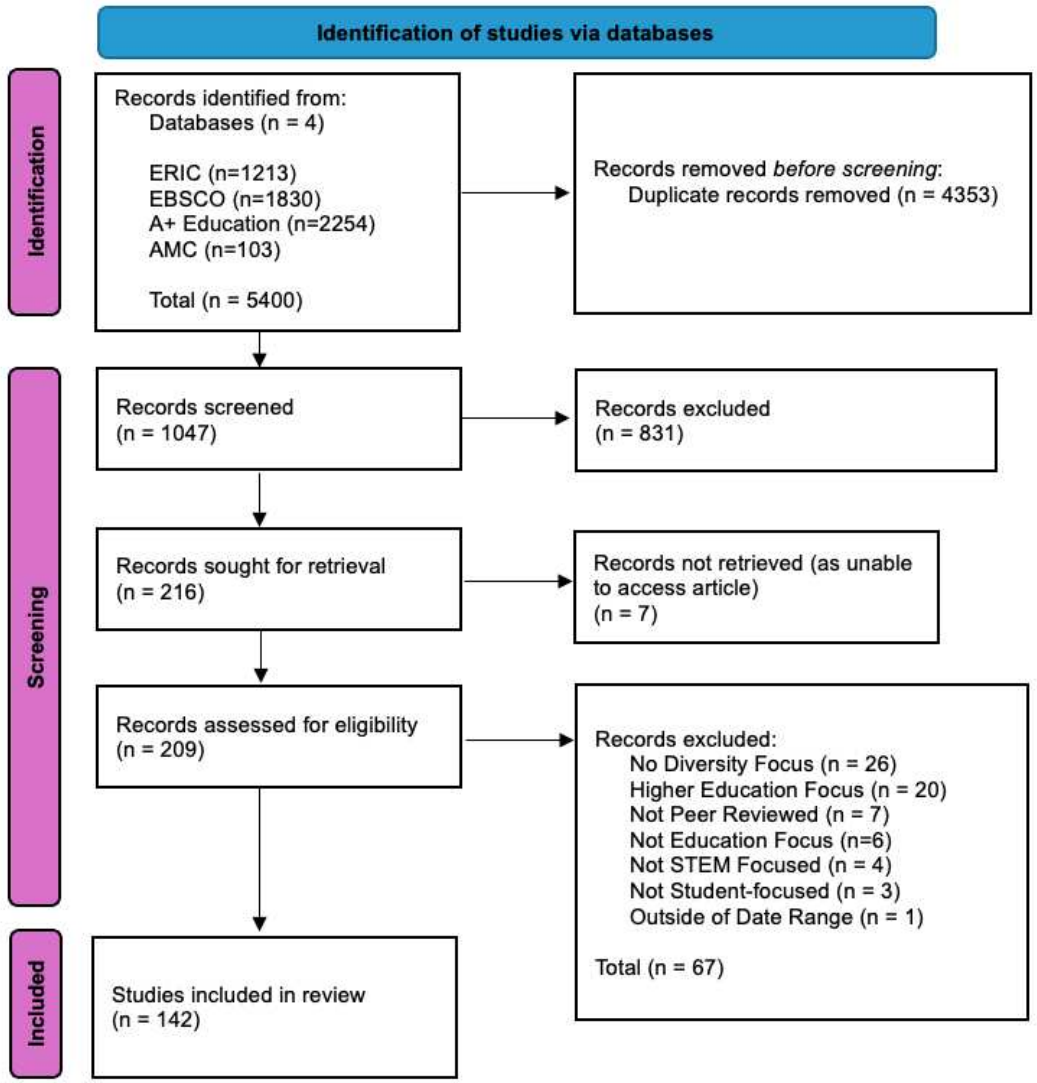

Fig 1: Flowchart of the study selection process following PRISMA guidelines (Page et al., 2021)

Quality Evaluation

To determine the quality of each study, a quality framework rubric identified and used by Margot and Kettler (2019) was employed by the researchers. The quality framework examines seven criteria, these are: Research Purpose & Scope, Literature Review, Theoretical/ Conceptual Grounding, Participants & Sampling, Methodology, Results and Conclusions, and Significance. Each article that aligned with the selection criteria was measured against each of the seven criteria to determine if they met the standards of quality reporting (Margot & Kettler, 2019; Mullet et al., 2017) (Table 2).

Each of the seven criteria was rated on a 4-point scale (1 = Does Not Meet Standard; 2 = Approaching Standard; 3 = Meets Standard; 4 = Exceeds Standard). Scores across all criteria were summed, yielding a total ranging from 7 to 28. Articles scoring 15 or below were excluded for failing to meet the minimum quality threshold. Following this process, 8 articles were excluded, and 134 were retained. To minimise the potential for bias, quality assessments were independently reviewed and confirmed by a second author. Interrater reliability for the quality assessment was calculated using Light's kappa on the total quality scores assigned to all 142 articles. Agreement between raters was almost perfect with $\kappa = 0.969$ ($z = 38.4$, $p < .001$; bootstrapped 95% CI [0.939, 1.00]) and simple percentage agreement of 97.2% (Gamer, 2019; Landis & Koch, 1977). Total scores differed for four articles; these were adjusted following discussion between all authors until a consensus was reached. A summary of the included articles can be found in Appendix 2 of the supplementary material.

Table 2. Quality assessment rubric

#	Criterion	4 — Exceeds Standard	3 — Meets Standard	2 — Approaching Standard	1 — Does Not Meet Standard
I	Research Purpose & Scope	Research problem, goals, and questions are precisely stated.	Research problem and goals are adequately stated. Inquiry questions and hypotheses are	Research problem and goals are present but underdeveloped. Inquiry questions may	Research purpose is absent or too vague to evaluate. No discernible goals,

		Hypotheses or expected outcomes are clearly identified.	present and identifiable.	be vague or incomplete.	inquiry questions, or scope.
II	Literature Review	Comprehensively maps the current state of knowledge. Situates the study within the broader field with compelling links to prior work. Synthesises and critiques ideas; identifies gaps, and unresolved issues. Introduces fresh perspectives.	Reviews prior work with adequate coverage. Connects the study to the broader field. Evaluates and synthesises ideas. Identifies some gaps or inconsistencies. Organised logically.	Covers relevant literature but lacks depth or breadth. Limited synthesis or critical evaluation. Few connections made to prior work. Organisation may be unclear.	Presents only a surface-level account of prior work. No meaningful synthesis, evaluation, or connection to the broader field. Poorly organised or incomplete.
III	Theoretical / Conceptual Grounding	Frameworks are clearly identified, described in detail, and explicitly justified. The rationale for choosing each framework is explained and supported. Alignment with the study's purpose is thoroughly argued.	Frameworks are identified and described. Selection is explained and supported. Alignment with study purpose is present, though may not be fully elaborated.	Frameworks are mentioned but not fully described. The rationale for their selection is implied rather than stated. Alignment with study purpose must be inferred.	No theoretical or conceptual framework is identified or discussed.
IV	Participants & Sampling	Population, sample, and sampling strategy are described in thorough contextual detail. Potential selection bias is acknowledged and addressed.	Population, sample, and sampling procedures are clearly described. Selection bias is noted.	Population, sample, and sampling procedures are described at a basic level. Contextual detail is limited; bias is not addressed.	Only the sample is described. Population and sampling approach are absent or critically incomplete.
V	Methodology	Procedures, analytical methods, and instruments are described with sufficient detail to allow replication. Validity and reliability evidence is provided. Potential sources of bias are discussed. Methodological choices are justified.	Procedures, analytical methods, and instruments are described adequately to support replication. Validity and reliability evidence is provided. Potential bias is addressed.	Procedures and instruments are described but lack sufficient detail for replication. Validity or reliability evidence is incomplete. Bias is not discussed.	Methods are described too briefly to support replication. No validity or reliability evidence is offered.
VI	Results & Conclusions	Results are presented in full detail with effective use of data displays to synthesise and visualise information. Discussion links findings to prior literature. Future research directions are proposed. Conclusions directly address the stated problem or questions. Implications and limitations are examined.	Results are complete and accompanied by appropriate data displays. Discussion connects findings to prior work. Future directions are suggested. Conclusions address the research problem. Implications and limitations are identified.	Results are presented but data displays are minimal or insufficient. Discussion does not adequately connect to prior literature. Conclusions address the problem at a surface level. Future directions, implications, or limitations may be absent.	Results are incomplete or absent. No meaningful discussion connecting findings to prior work. Conclusions fail to address the research problem or questions.
VII	Significance	Convincingly articulates both the scholarly contribution and practical value of the study. Situates the significance within and beyond the immediate field.	Scholarly and practical significance are clearly articulated within the context of the field.	Scholarly or practical significance is noted, but the articulation is neither clear nor persuasive.	Significance is not articulated.

Data analysis

Thematic analysis was used as the method for identifying, analysing and reporting themes within the retained articles. Following the qualitative data analysis principles outlined by Creswell and Creswell (2018), each article was systematically coded to identify a primary code, reflecting the central focus of the study. As the articles generally explored more than one aspect of STEM in relation to the focus diversity group, a secondary code was also captured for each article. These codes were then reviewed and grouped according to patterns of meaning, resulting in their allocation to one of eight overarching themes. In line with Tesch (1990) eight steps for thematic analysis, the process of allocating codes and assigning these codes to suitable themes involved iterative engagement with the data, moving between individual articles and the broader coded dataset to ensure that the final themes accurately represented the scope of the literature (Creswell & Creswell, 2018, p. 196).

Results

Diversity Groups

Among the 134 retained papers, research on girls in STEM dominated the dataset with 63 studies (47%), followed by 29 studies focusing on CALD people (22%) and 23 studies on people with disabilities (17%). Studies focusing on LGBTQIA+ or First Nations Australians were notably under-represented, with only 2 studies (1.5%) each (Fig 2.). Where a study addressed two diversity groups, such as research on 'Black girls', a secondary theme was assigned. Similar to trends seen in primary diversity groups, studies that focused on either girls or CALD students also dominated the secondary diversity group classifications.

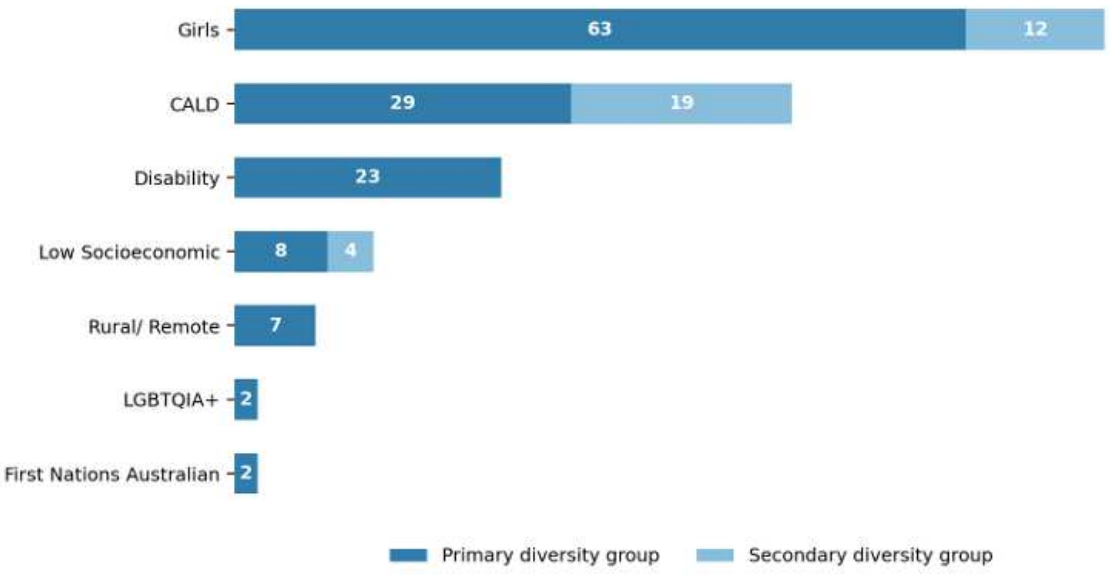

Fig 2: *Number of studies identified, along with the primary and secondary diversity groups identified in each study.*

STEM Focus

Half of the literature examined (67 studies) took a broad STEM lens, rather than focusing on a single discipline, while the remaining half addressed a specific STEM domain: Science (25 studies), Engineering (17 studies), Technology (15 studies), or Mathematics (10 studies) (Fig 3).

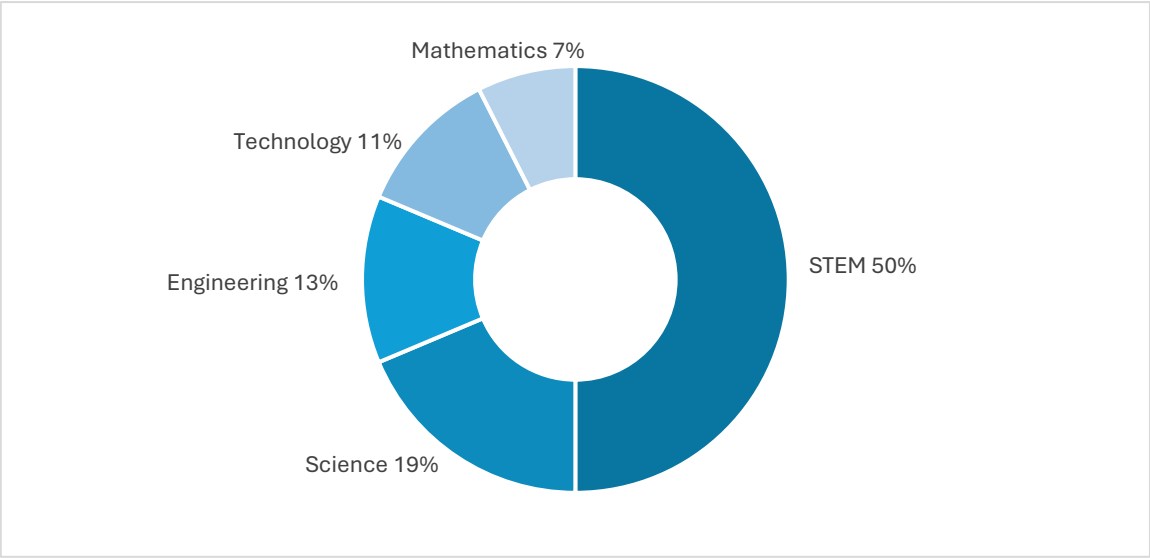

Fig 3. *Proportion of STEM domain focus within the included literature*

Girls' studies spread across all STEM areas but skewed heavily toward the broad "STEM" category, with similar trends seen within studies that focused on CALD students and students with disabilities. Several diversity groups and STEM domains were underrepresented or absent from the identified literature (Fig 4).

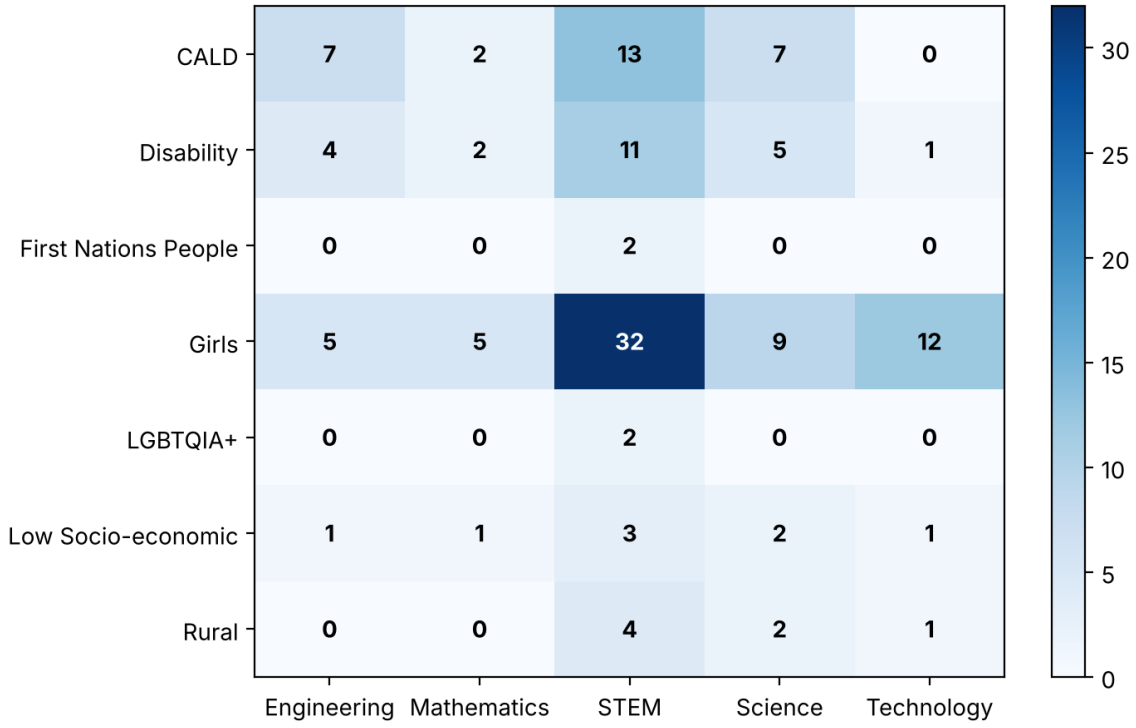

Fig 4. *Heatmap representing the relationship between diversity groups and STEM domain focus within the included literature.*

Thematic Analysis

An independent thematic analysis was conducted for the present review to examine how the diversity-focused literature identified in this review related to the principles established in the earlier systematic review of strategies for girls in STEM outlined above. Each of the 134 included studies was coded and mapped against these existing principles to identify areas of continuity and divergence across the broader range of diversity groups considered in this review. Where the current literature provided stronger, more recent, or more nuanced evidence than that available at the time of the original review, the relevant principles were updated and refined accordingly. Where the coded data revealed patterns of practice not captured within the original framework, new principles were developed and incorporated, grounded directly in the empirical evidence emerging from the included studies.

Thematic analysis of the included studies identified 59 unique primary and secondary codes, which were organised into eight key themes as seen in Fig 5.

The key themes identified were:

- Create safe and inclusive learning environments.
- Ensure everyone get hands-on.
- Design learning experiences that are culturally responsive and embrace context and problem-solving.
- Connect learning to careers and role models.
- Engineer collaborative learning.
- Provide choice and creative opportunities to demonstrate learning.
- Encourage a growth mindset.
- Integrate technology into learning.

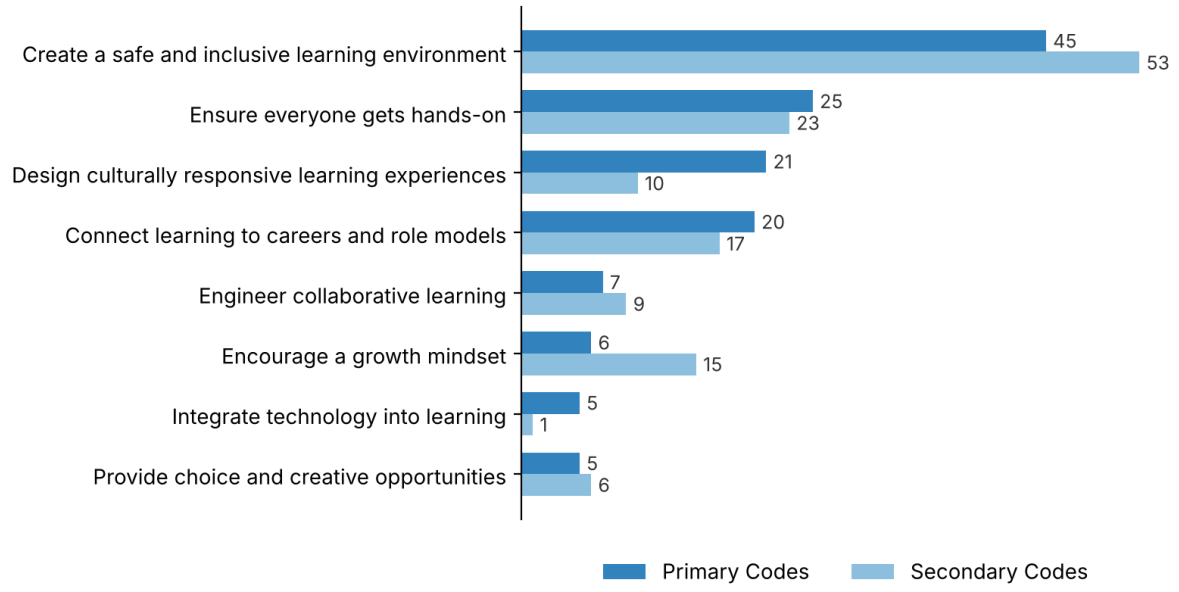

Fig. 5 *Distribution of primary and secondary codes across eight key themes.*

Theme 1: Create Safe and Inclusive Learning Environments

This theme had the highest representation across all articles, with 45 studies addressing it as a primary theme and a further 53 as a secondary theme. The most frequently occurring codes were stereotyping (n = 9) and accessibility (n = 7), followed by gender inequality (n = 6), gendered participation (n = 4), trusted and safe learning spaces, and detrimental or oppressive narratives (each n = 3). As a secondary theme, gender inequality was most prominent (n = 13), alongside stereotyping (n = 8), belonging (n = 6), and accessibility and inclusive teacher practice (each n = 5). The breadth and consistent appearance of this theme within literature reflect the extent to which issues of equity and inclusion permeate STEM participation for students with diversity.

Theme 2: Ensure Everyone Gets Hands-on

A total of 25 studies identified hands-on engagement as a primary theme, with a further 23 addressing it as a secondary theme. Hands-on or embodied learning was the most frequently cited code within this theme (primary n = 11; secondary n = 12), followed by STEM exposure

(primary n = 8). Additional themes included STEM gateways, inquiry and project-based learning, STEM experiences, and engagement in informal learning contexts. These findings indicate consistent evidence for the importance of active, experiential participation in supporting engagement with STEM among underrepresented groups.

Theme 3: Design Learning Experiences that are Culturally Responsive and Embrace Context and Problem Solving

Twenty-one studies addressed culturally responsive and contextually grounded learning as a primary theme, and 10 identified it as a secondary theme. Cultural connection and identity development were the most central code (primary n = 16; secondary n = 4), reflecting the strong emphasis in the literature on the role of cultural relevance in STEM engagement, particularly for CALD students and First Nations learners. Other themes included connecting STEM to real-world contexts, social and community connections, and using various mechanisms to 'bridge the gap', indicating that contextualised and culturally embedded learning is a well-evidenced strategy in the literature.

Theme 4: Connect Learning to Careers and Role Models

This theme was addressed as a primary code in 20 studies and as a secondary code in 17 studies, making it the third most represented theme in the literature. Mentorship or role models emerged as the most frequently cited code (primary n = 8; secondary n = 12), indicating its particular importance for supporting STEM identity and aspiration. Parental influence was also notable (primary n = 5; secondary n = 3), alongside career counselling, STEM aspirations, the influence of media, and partnerships with universities. Collectively, these themes point to the significant role that visible pathways and relatable figures play in shaping students' STEM engagement.

Theme 5: Engineer Collaborative Learning

Collaborative learning that had been specifically engineered for success was addressed as a primary code in seven studies and as a secondary code in nine. Collaboration was the most cited primary code (n = 5), while peer influence was the most prominent secondary code (n = 6). Interdisciplinary learning was also coded within this theme (primary n = 1; secondary n = 2). While this framework had more modest representation than others, the presence of both positive and negative peer dynamics signals that the social dimensions of STEM learning environments warrant continued attention so that educators can navigate these aspects when engineering collaborative learning opportunities.

Theme 6: Provide Choice and Creative Opportunities

This was among the least represented themes, with five studies identifying it as a primary code and six as a secondary code. Studies explored students' self-directed learning, engagement strategies, the use of gamification within learning, the consideration of students' interests, special interest clubs, and student participation in change. The limited evidence base for this framework suggests that learner agency and creative expression in STEM contexts remain underexplored in the literature, representing a potential area for future research.

Theme 7: Encourage a Growth Mindset

Growth mindset codes were more commonly identified as secondary rather than primary, with six primary and 15 secondary codes assigned to this theme. STEM confidence was the most frequently occurring code overall (primary n = 2; secondary n = 9), suggesting it tends to emerge as an outcome of other pedagogical approaches rather than a standalone focus of inquiry. Additional themes included STEM identity, self-efficacy, self-exclusion, metacognition, and acknowledgement and recognition during STEM learning.

Theme 8: Integrate Technology into Learning

The integration of technology into learning was an emerging theme throughout the works explored, with six studies addressing the theme. Five studies addressed the theme primarily, and one study addressed it as a secondary topic. The literature explored the use of technology during learning, particularly to increase accessibility, alongside the use of artificial intelligence and virtual learning. The relatively modest representation of this framework suggests that the literature is beginning to engage with technology integration in STEM education, with an emphasis on accessibility as a key enabling factor.

Discussion

Drawing on the findings presented, the following discussion addresses each of the three guiding research questions, considers the broader implications of the evidence base, and identifies directions for future research and practice.

RQ1: What school-based strategies are currently being used to promote diversity in K-12 STEM education?

The thematic analysis of the 134 included studies identified eight overarching categories of school-based strategy, reflecting a diverse and multifaceted approach to promoting diversity in STEM.

The most prevalent strategy identified across the literature was the creation of safe and inclusive learning environments. The dominance of this theme highlights the extent to which issues of equity, belonging, and psychological safety are foundational to STEM participation for students from underrepresented groups. Other studies have consistently emphasised the role of classroom culture in shaping students' willingness to engage with STEM, with accessibility, stereotyping, and gender and race inequality identified as the most frequent concerns (Adler et al., 2024; Chapman et al., 2020; Ford & Hines, 2025). The findings in this study align with broader research demonstrating that a sense of belonging and freedom from stereotype threat are critical preconditions for equitable STEM learning (Rainey et al., 2018; Veldman et al., 2021). Several other tactics, such as engagement in hands-on and experimental practices, culturally responsive pedagogy, and connection to careers and role models, each emerged as similarly prominent strategies within the literature (Adjapong, 2021; Andersen & Graham, 2025; Fennell, 2024; Pazey et al., 2024). This similarity suggests that no single pedagogical approach dominated the evidence base; rather, effective strategies were characterised by their combination of experiential, identity-affirming, and aspirational elements. For example, Speldewinde and Campbell (2023) combined hands-on exploration with cultural connection by

engaging First Nations girls in ‘Bush Kinder ’, promoting collaboration and play-based exploration of the natural world. Similarly, Solomon et al. (2022) utilised culturally linked embodied learning, specifically hip hop dance, to teach African American students the concepts of physics.

Career-connected learning, including mentorship, role modelling, and career counselling, was identified as critical for supporting STEM identity and aspirations. Literature identifies that students of diverse backgrounds often lack visible representation in STEM professions, often skewing attitudes and interest in STEM fields (Ford et al., 2024; Renken et al., 2021; Yong et al., 2023). Playton et al. (2021) demonstrated the strength of mentorship by pairing primary school students from a rural community with Computer Science (CS) researchers as mentors, which resulted in significant improvements in academic performance, interest in CS and positive attitudes towards the field, with gains particularly pronounced for girls.

While collaborative learning, growth mindset development, learner agency, and technology integration were less represented in the literature, the studies that did address these areas offered instructive examples of their application and limitations in practice. Collaborative learning, for instance, was evidenced in programs such as inclusive maker clubs for students on the autism spectrum (Chen et al., 2023; Chen et al., 2022) and robotics teams where CALD girls co-constructed engineering identities through peer support (Spruill et al., 2021; Zhong et al., 2023). However, the literature also reveals that collaboration can at times be detrimental to the STEM identity of students, as discovered by Kennedy (2023) during his exploration of girls in competitive robotics. He found that strong intragroup peer bonds drove participation yet did not translate into broader confidence within the STEM community, suggesting that collaboration within a protected group does not automatically build STEM belonging in wider contexts. Similarly, Wieselmann et al. (2020) documented how unstructured collaborative STEM tasks can reproduce gendered dynamics, with boys dominating decision-making and materials while

girls assumed observational and recording roles. These findings caution against assuming collaboration is inherently equitable without deliberate engineering of collaborative situations and dynamics. In contrast, studies that have deliberately engineered collaboration offer promising examples of how these dynamics can be addressed. Chen (2023) found that only 30% of autistic students took part in extracurricular activities. In response, the study introduced an extracurricular maker space, preceded by targeted inclusion training, that intentionally brought together autistic and non-autistic students alongside teachers, researchers, and maker program developers. This structured approach led to positive peer engagement, the development of relationships, and increased peer interaction and reciprocity. Learner agency and creative expression in STEM remain comparatively underexplored, representing a gap the literature itself acknowledges. The studies that do engage with these dimensions include design thinking workshops that built girls' creative self-efficacy (Kijima & Sun, 2021; Wingard et al., 2022) and makerspace programs that enabled LGBTQIA+ students to be the creators of intertwined queer and STEM identities (Tofel-Grehl et al., 2024). These studies demonstrate meaningful potential; however, there is insufficient evidence to draw robust conclusions about the effectiveness of these strategies.

Within technology integration, the literature points to teacher professional development as the critical enabling factor. Brigandi et al. (2021) found large effect-size gains in teacher confidence to deliver coding instruction following targeted professional development, and De Mars et al. (2022) identified highly qualified staff as an interconnected factors shaping STEM achievement in CALD schools, highlighting that technology alone does not drive outcomes, educator capability does.

Across all themes, it is notable that strategies were most frequently implemented in informal or extracurricular contexts, including after-school programs, summer camps, and community-

based initiatives, rather than as integral components of mainstream classroom instruction. While these settings offer valuable opportunities for targeted intervention, their reach is limited, and their capacity to effect systemic change in STEM participation may be constrained by their separation from formal schooling. This pattern echoes concerns raised in the broader literature about the scalability and institutional integration of diversity programs (Office of the Chief Scientist, 2020; Parsons & Banks, 2024). The equity groups targeted were closely linked to implementation style, whether formal curriculum alignment in schools or informal and extracurricular learning. Holiday programs, for example, focused mostly on girls, typically through single-gender camps, and on culturally diverse youth. Extracurricular programs also more often took an intersectional focus, particularly on culturally diverse girls, and were frequently framed as a 'counterspace' offering an alternative to classroom experiences identified as exclusionary (Edwards & King, 2023; Wade-Jaimes et al., 2021). In contrast, studies involving students from low socio-economic and rural backgrounds were almost exclusively curriculum-based (e.g., Ladachart et al., 2022; Playton et al., 2021; Yong et al., 2023). This is an important distinction, as these students may be the least able to access optional or fee-based programs.

The outcomes reported also differed by setting, with holiday programs, typically evaluated through single-group pre/post surveys, reporting consistent short-term gains in confidence, self-efficacy and interest (Grant, 2023; Martín-Peciña et al., 2025). However, these gains were often limited to the program's specific focus (Stewart et al., 2021), and participants frequently entered with high existing interest in STEM (Bindis, 2020; Sultan et al., 2024). Extracurricular programs were predominantly evaluated qualitatively and emphasised STEM identity and belonging (Ruiz-Bartolomé & Greca, 2023). Curriculum-based interventions more often used comparison or control groups and tended to demonstrate gains in knowledge and achievement

(e.g., Hwang et al., 2024; Jaudinez & Joaquin, 2023), although changes in attitudes and aspirations were less consistent (Ng & Fergusson, 2020; Vossen et al., 2023).

Importantly, studies examining both formal and informal settings found that identities developed in extracurricular spaces rarely transferred to the classroom (Wade-Jaimes et al., 2021, 2022). This reinforces concerns that benefits achieved outside mainstream schooling may not lead to sustained change within it. Taken together, these findings suggest that school-based and out-of-school approaches serve complementary functions, and that strengthening the connection between them is a key priority for future program design and research. However, because the implementation setting was confounded with study design and outcome measures, the relative effectiveness of each approach cannot be determined from the current evidence base.

RQ2: How effective are current school-based diversity strategies in improving the participation and retention of underrepresented groups in STEM?

The evidence regarding the effectiveness of school-based diversity strategies is broadly positive, though variable in its strength, consistency, and the diversity groups it addresses. Across several studies, targeted interventions produced meaningful improvements in students' STEM self-efficacy, interest, identity, and aspirations, particularly in the short term. However, the evidence base is characterised by considerable heterogeneity in methodology, intervention duration, and outcome measurement, making direct comparisons problematic and robust conclusions about overall effectiveness difficult to determine.

Strategies targeting girls in STEM

Research on girls in STEM constituted the largest share of the research in the included articles and demonstrated consistent positive effects across several types of interventions. Single-sex

programs, summer camps, mentoring initiatives, and design thinking workshops were associated with significant gains in STEM confidence, self-efficacy, and career interest across multiple studies (Bindis, 2020; Martín-Peciña et al., 2025; Wingard et al., 2022). Exposure to diverse role models was found to positively influence girls' STEM attitudes and reduce stereotypes, including in early childhood settings. However, some research cautioned that effects were highly inconsistent and dependent on the characteristics of the role model and the nature of the intervention (Buckley et al., 2022; De Gioannis et al., 2023; Vossen et al., 2023).

Structural interventions such as single-sex schooling demonstrated medium-effect-size improvements in mathematics and science achievement (Franklin & Rangel, 2024), while robotics and coding camps produced statistically significant gains in technology self-efficacy (Grant, 2023; Zhong et al., 2023). Several studies highlighted that the effectiveness of these interventions was greatest for girls who already held STEM interest, suggesting that strategies may be more effective at sustaining existing engagement than generating new interest among the least engaged (Stanberry et al., 2021).

Strategies targeting CALD students

Culturally responsive and identity-affirming strategies demonstrated particularly compelling outcomes for CALD students, including First Nations learners when empirical evidence was available. Curriculum units grounded in culturally diverse knowledge systems and community-embedded learning produced statistically significant improvements in STEM interest, knowledge, and cultural identity connection (Eglash, Bennett, et al., 2020; Eglash, Lachney, et al., 2020; Hunter et al., 2023). Ethnomathematics-based instruction significantly outperformed conventional instruction in mathematical thinking (Jaudinez & Joaquin, 2023), and culturally responsive pedagogy enabled students to develop stronger STEM identities while maintaining connections to community values and culture. Hip-hop pedagogy in science education

produced notable gains in science identity for girls of colour, with the proportion of participants self-identifying as scientists rising from 30% to 83% following one intervention (Adjapong, 2021).

Despite the strong evidence that cultural relevance and responsiveness to STEM instruction is not merely a matter of equity, but a driving force of improved engagement and outcomes for CALD students, a critical limitation of this premise within the Australian context is the underrepresentation of research on First Nations people. First Nations knowledges and cultures differ across countries and within groups, and findings from one cohort cannot be generalised for all First Nations peoples. This is a significant gap given the national policy to increase First Nations participation in STEM (Department of Industry Science and Resources, 2025). Further research on effective and practical classroom strategies for promoting participation among First Nations students is urgently required to ensure that First Nations identities and over 60,000 years of STEM innovation and knowledge are valued in STEM learning (Hoger, 2020).

Strategies targeting students with disability

For students with disabilities, empirical evidence shows that the most effective strategies are centred on accessibility adaptations, hands-on learning, and strengths-based approaches. Tactile-based science activities, adapted robotics programs, and assistive technology integration consistently enabled students with visual impairments and other disabilities to participate meaningfully in STEM learning alongside their peers (Akarsu et al., 2022; Hamash & Mohamed, 2021; Tsinajinie et al., 2021). Interdisciplinary STEM programs designed for students with learning disabilities produced significant and sustained gains in science vocabulary and problem-solving skills (Hwang et al., 2024), while inclusive informal learning, such as maker clubs, facilitated low-pressure and interest-based social participation and engineered identity development for students on the autism spectrum (Chen et al., 2023; Chen et al., 2022).

Emerging evidence also suggests that artificial intelligence and adaptive learning technologies hold promise for expanding accessibility in STEM assessment and instruction, though significant ethical concerns around algorithmic bias and data privacy require resolution before widespread implementation (Clark et al., 2025; Kohnke & Zaugg, 2025).

Strategies targeting students from low socioeconomic and rural backgrounds

Evidence for the effectiveness of strategies targeting students from low socioeconomic and rural backgrounds was modestly represented in empirical research. Mentoring by peer role models produced gains of up to 25% in favourable science perceptions among low-income students, particularly for girls of colour (Yong et al., 2023), while inquiry-based and project-based learning, particularly when connected to community-based projects or initiatives, were associated with improved science attitudes and engagement in rural school settings (Playton et al., 2021; Puslednik & Brennan, 2020; Sung et al., 2025). However, several studies highlighted those structural barriers, including limited access to advanced coursework, resource constraints, and teacher turnover, can undermine the effectiveness of well-designed programs at the implementation level (Kim et al., 2023; Stacy, 2025). The comparatively small number of studies that focused exclusively on the diversity groups within this review suggests that further targeted research is required.

Notable gaps in the evidence base

A critical limitation of the evidence base is the underrepresentation of research on LGBTQIA+ students and First Nations Australians, each of whom were the primary focus of only two studies each in this review.

The two LGBTQIA+ focused studies centred on makerspace and design-based learning contexts and provided encouraging findings regarding the co-construction of queer and STEM identities in affirming environments (Lemieux, 2024; Tofel-Grehl et al., 2024). The absence of a broader

evidence base makes it impossible to draw generalisable conclusions about which strategies are effective for engaging this group of students in STEM learning.

Similarly, the two studies addressing First Nations learners were centred on hands-on exploration of STEM concepts using only nature, and the importance of First Nations educators and role models to scaffold and connect learning concepts to cultural identity (McDaid Barry et al., 2023; Speldewinde & Campbell, 2023).

The lack of empirical evidence for these two diversity groups is a significant gap given the national policy imperative to increase diversity in STEM (Department of Industry Science and Resources, 2025).

RQ3: What individual, institutional, and systemic factors enable or hinder the success of diversity initiatives in school-based STEM education?

This systematic review identified a complex ecology of enabling and hindering factors operating at individual, institutional, and systemic levels. These factors interact across levels and often compound one another, meaning that success or failure rarely reflects a single cause.

Individual-level factors

At the individual level, STEM self-efficacy, identity, and sense of belonging emerged consistently as pivotal mediating variables. Students' belief in their own STEM capability was a stronger predictor of participation than objective achievement in several studies (Chan, 2022; Dohn, 2022; Kim et al., 2025), while a strong STEM identity, the sense of “being a STEM person” was found to mediate the relationship between motivational beliefs and STEM career aspirations (Myint & Robnett, 2024). Conversely, gender stereotypes, racial stereotypes, and deficit narratives were identified as significant barriers that undermined STEM belonging and motivation, particularly for girls and culturally diverse students (Master et al., 2025; Msambwa et al., 2024; Steegh et al., 2021). Intersecting identities, such as being a First Nations woman

from a regional area, were shown to compound disadvantage, reinforcing the importance of intersectionality as both an analytical and practical consideration (Boda, 2024; King, 2022; Whitcomb et al., 2021).

Parental influence emerged as a nuanced factor. While parental STEM encouragement was strongly associated with positive STEM outcomes, particularly when parents participate actively in STEM discussion and career-specific encouragement (Starr et al., 2025), the nature of parental influence was often found to be gender-differentiated. Fathers' educational expectations positively predicted STEM subject choice in some cultural contexts (Le et al., 2025), while parental utility value beliefs had stronger effects on sons' STEM outcomes than daughters' (Lee et al., 2020). Family-inclusive STEM programs, where families actively participate in STEM interventions with their children, demonstrated sustained improvements in girls' science identity and career aspirations (Rillero et al., 2025), suggesting that engaging families can be an important amplifier of school-based intervention.

Institutional-level factors

At the institutional level, teacher beliefs, inclusive pedagogical practices, and classroom culture were among the most consistently identified enabling factors. Teachers who actively challenged gender stereotypes, implemented culturally responsive pedagogy, and provided equitable access to hands-on STEM experiences were associated with better outcomes for diverse students (Stephenson et al., 2022; Wang, 2024). Professional development that built teacher capacity to recognise and address unconscious gender bias was found to shift practice meaningfully, though the depth of change varied across educators (Brigandi et al., 2021; Stephenson et al., 2022; Wang, 2024). Several studies also found that teachers' allocation of scientific questions and learning opportunities was unconsciously gendered at the preschool level, with boys being asked more questions at the science table, not because of deliberate bias, but because boys spent more time in that space (Kumar et al., 2024). This finding

highlights the importance of proactive teacher scaffolding in ensuring equitable STEM access and encouragement from the earliest years.

School culture and the availability of inclusive physical and social spaces were also identified as important institutional enablers. Schools that created deliberate counterspace, environments explicitly designed to affirm the identities of underrepresented students and provide refuge from stereotype and marginalisation, reported strong outcomes in terms of belonging, confidence, and STEM identity development (Edwards & King, 2023; King et al., 2023; Tofel-Grehl et al., 2024). Conversely, when dominant school cultures embedded deficit narratives for diverse students or enforced rigid behavioural norms that prioritised conformity over agency, they undermined the effectiveness of even well-designed complementary programs (Wade-Jaimes et al., 2022). The physical accessibility of STEM laboratory and classroom spaces emerged as a further institutional barrier for students with physical disabilities, with current accessibility regulations generally representing only a minimum baseline rather than genuinely inclusive design (Taylor et al., 2025).

Mentorship and the representation of diverse role models within school and program contexts were identified as particularly important institutional enablers. Across multiple studies and diversity groups, the visible presence of relatable role models, whether peer mentors, teachers, or STEM professionals, played a significant role in strengthening students' STEM identity and sense of possibility (De Gioannis et al., 2023; Ford & Hines, 2025; Henderson et al., 2021; Ibourk et al., 2022). The absence of role models who shared students' racial, cultural, gender, or disability identity was equally identified as a persistent barrier, contributing to feelings of not belonging in STEM spaces.

Systemic-level factors

At the systemic level, inequitable access to STEM resources, lack of advanced or extension coursework, and funding constraints were identified as persistent barriers impacting STEM

learning. Several studies highlighted the well-documented risk that resource allocation decisions aimed at closing achievement gaps can simultaneously widen excellence gaps by restricting access to advanced learning for high-achieving students from diverse backgrounds (Mohamed et al., 2025; Stacy, 2025; Steegh et al., 2021). The absence of diverse and culturally relevant curriculum content within mainstream schooling, including the limited integration of First Nations knowledge systems and the near-absence of LGBTQIA+-affirming STEM content, was identified as a structural barrier that well-intentioned intervention programs often cannot fully compensate for due to the scalability of these programs (Department of Industry Science and Resources, 2025; Tofel-Grehl, 2023).

Research suggests that successful STEM programs tend to be characterised by deep institutional integration, sustained funding from multiple sources, and strong partnerships between schools, families, and industry partners, including universities and community organisations (Parsons & Banks, 2024; Puslednik & Brennan, 2020). Programs that rely on a single supporter, external grant funding, or short-term implementation cycles are vulnerable to discontinuation when those supports are removed. This structural fragility is particularly concerning given the evidence that early and sustained engagement with STEM is necessary to prevent disengagement at critical transition points across schooling (DeWitt et al., 2014; Godwin et al., 2013).

Implications for Practice

The findings of this review carry several important implications for STEM educators, school leaders, and policymakers. First, creating safe and inclusive learning environments is not merely a prerequisite for effective STEM teaching; it is an active pedagogical strategy that requires ongoing, deliberate attention at individual, institutional and systemic levels. Schools need to invest in professional development that builds teacher awareness of stereotyping, unconscious bias, and the differential experiences of students from underrepresented groups, and should create structures that hold institutions accountable and support education staff, to encourage and maintain equitable STEM access.

Second, the consistent positive effects of culturally responsive pedagogy, particularly for CALD students and First Nations learners, suggest that embedding cultural relevance within mainstream STEM instruction, rather than relegating it to supplementary programs, should be a priority for curriculum design and teacher preparation. This requires schools to move beyond tokenistic acknowledgements of diversity toward genuine co-design of learning experiences with students, families, and communities.

Third, the evidence on role models and mentorship supports the expansion of programs that connect students from underrepresented groups with STEM professionals who share their identities and backgrounds. While one-off visits and short-term mentoring programs have demonstrated modest benefits, sustained mentoring relationships and long-term exposure to diverse STEM role models are likely to produce more durable shifts in STEM identity and aspiration.

Fourth, the growing body of evidence on technology integration, including adaptive learning platforms and AI-assisted accessibility tools, suggests that careful and ethically grounded use of technology can expand STEM access for students with disabilities and from remote communities. This potential must be balanced against the well-documented risks of

algorithmic bias and the critical importance of adequate teacher professional development to support meaningful technology implementation.

Fifth, STEM programs should be intentionally designed to develop transferable skills and dispositions that consistently support engagement across equity groups. Collaboration was one of the most prominent, with peer collaboration enabling full participation for students with disabilities (Akarsu et al., 2022; Chen et al., 2023; Kapucu & Kızılaslan, 2022), increasing engagement and creative confidence among girls (Wingard et al., 2022; Yabas et al., 2022; Zhong et al., 2023), and helping students from low socio-economic backgrounds adapt to demanding STEM programs (Kim et al., 2023). However, collaboration must be deliberately structured to avoid dominant students taking over (Wieselmann et al., 2020; Stephenson et al., 2022). Programs should also be framed around real-world, socially meaningful problems, as utility value and communal purpose were particularly influential for girls (Dohn, 2022; Martín-Peciña et al., 2025) and community-anchored engineering design supported identity development (Benavides et al., 2023; Roby et al., 2023). Sense of belonging and self-efficacy consistently shaped STEM interest and aspirations (Chan, 2022; Master et al., 2025; Myint & Robnett, 2024), making them key outcomes to design for and measure. Given that students from low socio-economic and rural backgrounds were reached almost exclusively through curriculum-based programs, embedding these features in everyday classroom teaching is essential to ensure they benefit the students with the least access to extracurricular opportunities.

Recommendations for Future Research

This review has identified several significant gaps in the current evidence base that future research should address. Most urgently, the profound underrepresentation of studies focusing on LGBTQIA+ students and First Nations Australians demands targeted research investment. Given that these groups face some of the most significant and compounding barriers to STEM participation, in addition to Australia's national policy commitment to increasing their representation in the STEM workforce, the absence of a robust school-based evidence base is a critical blind spot.

Future research should also prioritise studies that examine the long-term impact of diversity interventions on STEM subject selection and career entry, rather than focusing exclusively on short-term attitudinal and emotional outcomes. Longitudinal designs that follow students through key transition points, including the critical primary-to-secondary transition and the movement from secondary schooling into tertiary education and employment, would substantially strengthen the evidence base for sustainable investment in diversity strategies.

Finally, greater attention to intersectionality is warranted. Most studies in this review focused on one or two diversity groups, most commonly gender, without examining how multiple identities interact to shape STEM outcomes. Where intersectional approaches were used, they largely focused on race and gender and were concentrated in extracurricular settings, meaning they share limited reach and wear transfer to classrooms. Research that explicitly examines the experiences of students navigating multiple marginalised identities, such as First Nations girls with disabilities from low socioeconomic backgrounds, and that does so within mainstream classrooms, would provide more nuanced and actionable guidance for educators working in complex, diverse school communities.

Limitations

Several limitations of this review should be noted. The search was conducted in October 2025 and was restricted to peer-reviewed full-text articles in English published between 2020 and 2025, meaning that grey literature, policy reports, and non-English language research were excluded from the data pool. While this scope ensures a high-quality evidence base, it may have excluded relevant program evaluations and practice-based evidence that did not meet formal publication criteria. The geographic distribution of the evidence base was heavily skewed toward North American contexts, with a significant proportion of studies conducted in the United States. This limits the direct transferability of findings to other school contexts such as those of Australia, particularly given the distinctive cultural, policy, and demographic characteristics of the Australian STEM education landscape.

The methodological diversity of the included studies also poses challenges for synthesis. The evidence base spans quasi-experimental designs, qualitative case studies, mixed-methods investigations, and theoretical frameworks, making direct comparisons of frameworks and intervention efficacy difficult. While thematic analysis was appropriate for capturing the breadth of approaches and experiences represented in the literature, it does not allow for the kind of quantitative meta-analysis that would enable stronger claims about the effectiveness of specific strategies.

Conclusion

This systematic review demonstrates that a substantial and growing body of evidence supports the use of school-based strategies to promote diversity in K-12 STEM education. The most effective approaches share a common emphasis on creating environments where all students, regardless of gender, cultural background, disability, geographic location, or socioeconomic circumstance, can see themselves as capable and valued STEM learners. Safe and inclusive learning environments, culturally responsive and experiential pedagogy, accessible hands-on learning, and meaningful connections to careers and diverse role models are among the most consistently evidenced strategies for improving participation and outcomes for underrepresented groups.

The evidence makes clear that individual and programmatic interventions, however well-designed, are insufficient on their own to address the systemic inequities that shape STEM participation from the earliest years. Sustained progress will require action at multiple levels, from classroom practice and school culture through to curriculum design, teacher education, and policy. Inclusive STEM frameworks and policymakers must commit to designing and evaluating interventions that address the intersecting and compounding disadvantages faced by the most marginalised groups. The lack of empirical evidence on severely underrepresented groups, particularly LGBTQIA+ students and First Nations Australians, highlights the urgent need for targeted research and practice that ensures no student is left behind in STEM.

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